JOSHUA TREE NATIONAL PARK
GEOLOGIC RESOURCES MANAGEMENT ISSUES
SCOPING SUMMARY

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12/15/03

Executive Summary

In a Geologic Resources Evaluation scoping meeting held at the headquarters of Joshua Tree National Park (JOTR) in Twentynine Palms, California, May 1, 2003, the scoping meeting participants identified the following geologic resources management issues.

1. Desert crusts and desert pavement are being threatened by social trails near climbing sites and by OHV use.

2. Groundwater levels are being impacted by adjacent development, especially south of the park.

3. Groundwater quality is being impacted by urban development from greater Los Angeles.

4. Surface water quality and quantity is threatened by lowering of groundwater levels, invasion by non-native plants species, air pollution, and deposition from Los Angeles.

5. Seismicity is an important issue impacting health and safety, surface water flow from springs, and the siting of park structures. The Joshua Tree area is seismically active.

6. Mineral extraction and abandoned mineral lands (AML) has resulted in metal contamination, health and safety issues concerning open adits and shafts, and concern for bat habitat.

7. Soils are being impacted by the influx of nitrates and contaminants from urban areas and potentially from the proposed Eagle Mountain landfill.

8. Paleontological resources have not been adequately inventoried and are being threatened by loss, mainly from erosion.

Introduction

The National Park Service held a Geologic Resources Evaluation scoping meeting at the headquarters of Joshua Tree National Park (JOTR) on Thursday, May 1, 2003. The purpose of the meeting was to discuss the status of geologic mapping in the park, the associated bibliography, and the geologic issues in the park. The products to be derived from the scoping meeting are: (1) Digitized geologic maps covering the park; (2) An updated and verified bibliography; (3) Scoping summary (this report); and (4) A Geologic Resources Evaluation Report which brings together all of these products.

Joshua Tree was proclaimed a national monument on August 10, 1936. Joshua Tree National Park was created under Title IV of the California Desert Protection Act (Public Law 103-433) on October 31, 1994. The Act also added about 234,000 acres of public land for a total area of 1,022,976 acres, with 456,552 acres of wilderness. Generally, JOTR is bounded on the south by Interstate Highway 10, on the north and west by California state highway 62, and on the east by Colorado River Aqueduct (see attached map).

Joshua Tree National Park is covered by 48 7.5-minute quadrangles of interest. Park staff identified five quads that should be mapped at 1:24,000: Twentynine Palms, Malapai Hill, Fried Liver Wash, Yucca Valley South (highest priority) and Joshua Tree South (west entrance to park). Keith Howard has published a geologic map of the Sheep Hole Mountains 30'x60' quadrangle. Dibblee has mapped the Twentynine Palms quadrangle and the Joshua Tree quadrangle, both at a scale of 1:62,500. Robert Powell has mapped the Pinto Mountain, Porcupine Wash, San Bernardino Wash and Conejo Well 7.5 minute quadrangles.

Physiography

Joshua Tree National Park lies at the eastern terminus of the Transverse Ranges physiographic province. The Transverse Ranges are unusual in that they trend east-west rather than north-south as do most ranges. The Transverse Ranges province extends about 325 miles from Point Arguello and San Miguel Island on the west coast of California to the Coxcomb Mountains in JOTR on the east (Norris and Web, 1976). Principal mountain ranges include the Little San Bernardino Mountains to the southwest, the Pinto, Cottonwood, and Hexie Mountains in the central part, and the Eagle and Coxcomb Mountains on the east end. Elevations are generally between 2,000 to 4,000 feet. The highest point is 4,562 feet at Twentynine Palms Mountain.

Geology

The Precambrian Pinto gneiss, named by Miller (1938) from its occurrence in the Pinto Mountains, is the oldest rock in JOTR and is exposed in much of the high desert of JOTR (Trent, 1984). Radiometric dating gives ages between 1650 and 1400 million years (Powell, 1982). It is 100 to 500 feet thick. The Pinto gneiss is composed mostly of metasediments and metavolcanics as indicated by the layering and foliation. The layering is in alternating bands ranging from less than an inch to several yards in thickness. The gneiss, ranging in composition from a quartz monzonite to a quartz diorite, is composed mainly of quartz, feldspar, and biotite. The darker gray bands contain more biotite.

The Pinto gneiss is cut and intruded by both the Palms granite and the Gold Park diorite. The Palms granite is also known as the 29 Palms quartz monzonite (Brand and Anderson, 1982) and as the 29 Palms porphyritic quartz monzonite. The type area is in 49 Palms Canyon and it is also exposed along the arroyo on the east side of the Indian Cove campground. It forms the oldest of the Mesozoic intrusions (Jurassic) and, according to Neumann and Leszcykowski (1993), it is part of the Cadiz Valley batholith, one of several intrusives which constitute the Jurassic pluton belt of the western U.S. (Powell, 1982) emplaced during the Andean Orogeny.

The composition by volume of the foliated part of the Palms granite is as follows: quartz, 37%; feldspar 57.5%, biotite, 2.3%; magnetite, 1.1%; sericite, 0.7%; with minor epidote, zircon, allanite, titanite, apatite, and garnet. The composition by volume of the non-foliated, massive rock ("a quartz monzonite," Miller, 1938) is as follows: quartz, 28%; feldspar 64% ; biotite, 4.3%; epidote, 1.3%; magnetite, 0.7%; garnet, 0.6%; sericite, 0.4%; and zircon, titanite, allanite, and apatite, 1.4%. The foliated and non-foliated rocks are derived from the same magma but, the foliation is due to the contact with and assimilation of the older Pinto gneiss. Where the Palms granite is in contact with the Gold Park gabbro, the granite becomes more of a granodiorite – darker, more basic, and more foliated.

The next oldest pluton is the Queen Mountain monzogranite, exposed around Queen Mountain in the northern part of the park. The monzogranite is coarse-grained and consists of plagioclase, potassium feldspar, quartz, biotite and hornblende.

The Gold Park diorite, which Miller (1938) called a gabbro-diorite, is a composite rock named from its occurrence in Gold Park Canyon. The rock includes diorite, gabbro-diorite, gabbro, olivine gabbro, norite, hornblende diorite, and hornblendite. It is mostly medium-grained to coarse-grained and medium-gray to black. The hornblende diorite may be porphyritic with laths of hornblende larger than the feldspar. The massive facies has 50% to 70% feldspar and 5% to 35% hornblende and biotite. Miller (1938) states that the Gold Park gabbro-diorite is older than the Palms granite but younger than the Pinto gneiss.

The Cretaceous White Tank monzogranite is exposed in much of the park including the Little San Bernardino Mountains, Lost Horse Valley and Queen Valley. It is similar to the Queen Mountain monzogranite, but is finer-grained and contains only small amounts of biotite and no hornblende. The White Tank monzogranite is exposed in Indian Cove, the Wonderland of Rocks, Jumbo Rocks, White Tank and Lost Horse valley (Trent, 1984).

The youngest Cretaceous pluton is the Oasis monzogranite. It is distinctive in that it is garnet-bearing. The garnets are small, but visible to the unaided eye, and blood red. Muscovite mica gives the rock a shiny, glittery appearance.

The youngest igneous rocks, exposed in the Pinto Mountains, are igneous dikes composed of andesitic basalt and of fine-grained granitic rock or aplite. These dikes are Upper Cretaceous to Tertiary (Laramide) in age. The basalt dikes are green to black and fine-grained. The aplite dikes are white to gray and usually long and narrow in outcrop. Cutting these dikes as well as older rock are veins of milky quartz that contain pyrite (fools gold) and gold. The pyrite (iron sulfide), oxidizes to red hematite which stains the quartz. This red coloration has lead prospectors to look for gold, silver and copper.

There also are occurrences of basalt, as surface flows near Pinto Basin and as volcanic domes at Malapai Hill and in the Lost Horse Mountains. The basalt at Malapai Hill is a lherolite, composed of about 75% olivine with the remainder being mostly pyroxene. This indicates a source for the lava from the mantle.

<u>Structure</u>

Joshua Tree National Park is generally bounded on the north by the Pinto Mountain fault and on the south by the Blue Cut fault. Both are left-lateral strike-slip faults (Trent, 1984). The Pinto Mountain fault is the most prominent, extending east-west along State Highway 62 between Morongo Valley and Twentynine Palms and then continues further to the east. The springs forming the oasis at the park Visitor Center in Twentynine Palms is evidence of the fault. The fault is at least 73 kilometers (117 miles) long and may be as long as 90 kilometers (145 miles). It appears to be a branch of the Mill Creek and Mission Creek fault system which forms the north branch of the San Andreas Fault. Movement along the Pinto Mountain fault indicates that the Pinto Mountains have moved eastward and been uplifted relative to the valleys to the north. The rate of movement is about 1.0 mm/year. The fault is active today, the last movement recorded in 1992 in response to the Landers earthquake.

To the south, the Blue Cut fault extends through the Little San Bernardino Mountains, about half a mile south of Keys View in the park, then eastward north of Pushawalla Canyon and Pushawalla Plateau through a narrow valley known as The Blue Cut. It continues eastward under Pleasant Valley through the Hexie Mountains into Pinto Basin. It is at least 30 kilometers (48 miles) long and likely much longer. From Pleasant Valley eastward it is covered by Quaternary alluvium. The Blue Cut fault branches off from the Dillon fault (Trent, 1984) which is itself a southeastward branch of the San Andreas fault system. Relative movement along the fault has been a shift of the Pinto Mountains to the west with some relative down-drop north of the fault. There does not appear to have been significant movement on the fault in the Holocene. In addition to these two major faults, there are hundreds of minor faults throughout the park resulting in the springs and oases in the park.

Significant Geologic Resource Management Issues in Joshua Tree National Park

1. Desert crusts and desert pavement

Desert crusts are delicate and, if undisturbed, will remain for a long period of time. However, there are impacts from road openings and closures and from illegal off-road activity. Efforts by the State of California to claim road and trails under RS 2477 may put more area of desert crusts in peril. Other impacts include foot traffic from visitors and park administrative actions, such as siting of facilities. Jayne Belnap, USGS Research Ecologist at the Canyonlands Field Station, has been monitoring the condition of desert crust in the park. Questions that should be addressed are: Where are the desert crusts and desert pavement in the park and how extensive are they? What are the impacts of OHV use on desert crusts? What is the rate of recovery of desert crusts and desert pavement? How is visitor use impacting desert crusts?

2. Groundwater level

In an arid environment, groundwater level is an important issue. With the rapid population growth of Southern California, there has been significant development to the south of the park. The Southern California Metropolitan Water District (MWD) is planning to extract increasing amounts of water for the Los Angeles area. Currently, the park is monitoring water levels at the Oasis of Marith. There is a need for baseline groundwater level data for Pinto Basin as well. There are wells in the Pinto Basin but the park does not have the data from these wells. New visitors center is planned near the Oasis of Mara in cooperation with the town of 29 Palms. There is a need to disseminate information to the town regarding the groundwater and the need to preserve the oasis.

There are many variables relating to groundwater including the impacts from seismic activity and drawdown from human use. A proposed landfill in the Eagle Mountains to the southeast could have considerable impact on water level as well as water quality. The park would like a map of the groundwater levels and the configuration of the aquifers. Questions to be asked include: What are the development plans for the MWD? Is acid mine drainage from abandoned mines an issue? How are groundwater levels changing in response to surrounding development? Has there been subsidence from groundwater withdrawal? How are park oases and spring communities changing in response to decreased groundwater levels?

3. Groundwater Quality
The quality of the groundwater is an important issue due to potential impacts from the greater Los Angeles area. There is potential for air pollution from LA to end up in the groundwater. There may also be contamination from LA wastewater pluming into park. Monitoring and research questions include: What are the interconnections between aquifers within and outside the park? What is the pattern of groundwater flow? What are the principal groundwater contaminants and what is the potential impact on park resources? Is groundwater quality declining?

4. Surface Water
There are no perennial streams in Joshua Tree NP. Surface water is either from precipitation or from springs. The location and number of springs is related to both precipitation and faulting (see above). There is some evidence that springs disappear and reappear in another location, possibly due to seismic activity. The park is conducting intensive water chemistry research on about 20-25 springs. Both the quality and the quantity of surface is being impacted by the drawdown of groundwater levels, the invasion by non-native plants species, by air pollution from urban areas, and by particulate deposition from LA smog. Monitoring questions include: What is the response of springs to earthquakes activity in terms of flow amounts, fluctuations in flow, creation of new springs and decline of others. What is the impact of park road maintenance on water sheet flow across desert floor? What are the impacts of visitor use on ephemeral pools (e.g. Rattlesnake Canyon)? What are the impacts of visitor use on Palm Fan Oases in terms of quantity and quality of water, plant and animal communities, etc. Are plant and animal communities changing in response to changes in groundwater quality?

5. Seismicity
As discussed in the Geology section above, the park mostly lies between two major faults related to the San Andres fault system and has probably hundreds of faults, many of them active. The park currently has 3-4 monitoring stations. Seismic monitoring is increasingly vital as the surrounding population grows and as the park continues development of facilities and visitors centers. The new visitors center near the Oasis of Mara is located on a fault line as well as in a floodplain. The USGS wants to put in more monitoring stations but needs to find appropriate locations outside wilderness. Questions: Are surface displacement and seismicity related and if so, how? Are any faults connected to the propose Eagle Mountain landfill, and if so, what potential impacts can be expected?

6. Mineral extraction
JOTR has a long history of prospecting, mining and milling. Abandoned adits, shafts, pits, and gold mills are scattered throughout the park. Abandoned mineral lands (AML) are a significant issue in the park. The park does have a GIS layer showing the location of AML sites. Abandoned mines are frequently used as bat habitat. Many mine openings require complete closure (e.g., using “Puff” methods) but other require bat gates allowing bats to roost and nest but keeping humans out. Bat protection is a significant issue related to mine closures. Tailings from 14 mill sites have been tested and found to contain mercury which was used for amalgamation and recovery of gold. These sites need further testing for other contaminants such as arsenic and for clean-up. The park has located and mapped the known borrow pits. Questions: Is contamination from mining wastes changing (i.e., increasing/decreasing) over time? Have all abandoned mine sites been located and characterized?

7. Soils

Increased nitrogen deposition from air and water influx from the LA area has had an impact on the flora of the park. In an ecosystem that has adapted to a low nitrogen environment, a significant increase in nitrogen leads to an increase in non-native plants, especially grasses, thereby altering the fire regime in an ecosystem not well adapted to fire. Monitoring questions: Is the amount of nitrogen in the soil changing over time? What are the impacts of nitrogen deposition on soil chemistry? What is the relationship between the location of the cholla cactus garden and the geology? Are the physical properties (e.g. compaction) of soils in the park, especially in oases, changing? Is the amount of disturbed land (roads, pipelines, fires, etc.) increasing? How much of the disturbance is caused by visitors?

8. Paleontological resources

There are nine known paleontological sites throughout park with potentially significant paleontological resources. Most of the sites occur in the Pinto Basin. It is likely that there are more unexplored paleontological resources in park. The major threat to these resources is from erosion leaving paleontological lag deposits that may be scattered, lost, or collected by visitors. The transition zone between the Sonoran Desert and the Mojave Desert provides an opportunity to document historic changes in flora (from pollen) and fauna (from pack rat middens). The park needs an inventory and survey of paleontological resources particularly on alluvial fans and lacustrine deposits. There is also a need for a paleontological management plan. Monitoring questions are: Is the condition of known paleontological resources stable? From the fossil record, how has the flora and fauna of the park changed over time?

Other issues:

Wind Erosion and Deposition

Although generally considered by the park not to be a significant issue, wind erosion may be related to cultural resources such as the destruction of petroglyphs from sand blasting. Sand and silt deposition also impacts cultural resources by burying petroglyphs and artifacts requiring park staff to uncover them, if they have been previously known. The park has only one “sand dune” in Pinto Basin, which it is really a sand veneer over a granite ridge.

Hazards

Rockfalls and topple are not a major issues in the park. However, due to the health and safety aspect, rock fall hazards should be closely monitored. Monitoring questions include: What areas are susceptible to rockfall and topple? What are the impacts of climbers? What are the impacts of visitors on fault escarpments? Are the number of climbers and rate of rockfalls increasing? How does the monzogranite weather and at what rate?

Scoping Meeting Participants

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Eric Scott	Curator of Paleontology	San Bernardino County Museum
Dar Spearing	Interpreter/Geologist	Joshua Tree National Park
Dee Trent	Geologist	Retired geologist
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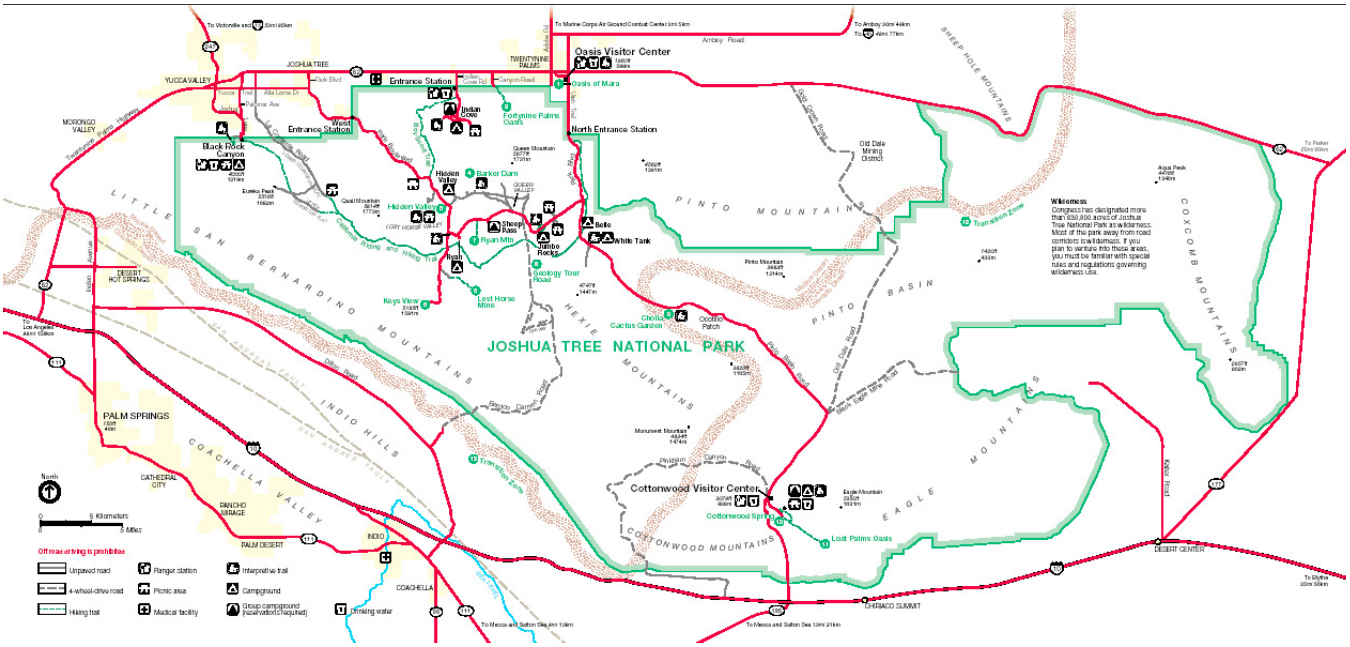

JOSHUA TREE NATIONAL PARK
Oasis Visitor Center
Cottonwood Visitor Center
Entrance Station
West Entrance Station
North Entrance Station
Black Rock Canyon
Indian Cove
Hidden Valley
Barker Dam
Sheep Pass
Ryan Mtn
Jumbo Rocks
Belle
White Tank
Ryan
Keys View
Lost Horse Mine
Geology Tour Road
Cholla Cactus Garden
Ocotillo Patch
Oasis of Mara
Fortynine Palms Oasis
Cottonwood Spring
Lost Palms Oasis
Transition Zone
YUCCA VALLEY
JOSHUA TREE
TWENTYNINE PALMS
MORONGO VALLEY
DESERT HOT SPRINGS
PALM SPRINGS
CATHEDRAL CITY
RANCHO MIRAGE
PALM DESERT
INDIO
COACHELLA
CHIRIACO SUMMIT
DESERT CENTER
LITTLE SAN BERNARDINO MOUNTAINS
HEXIE MOUNTAINS
PINTO MOUNTAINS
PINTO BASIN
EAGLE MOUNTAINS
COTTONWOOD MOUNTAINS
COXCOMB MOUNTAINS
SHEEP HOLE MOUNTAINS
INDIO HILLS
COACHELLA VALLEY
SAN ANDREAS FAULT
Old Dale Mining District
Old Dale Road
Black Eagle Mine Road
Pinto Basin Road
Pinkham Canyon Road
Berdoo Canyon Road
Dillon Road
Amboy Road
Kaiser Road
To Victorville and 15 53mi 85km
To Marine Corps Air Ground Combat Center 3mi 5km
To Amboy 30mi 48km
To 40 48mi 77km
To Parker 60mi 96km
To Blythe 35mi 56km
To Los Angeles 98mi 158km
To Mecca and Salton Sea 8mi 13km
To Mecca and Salton Sea 13mi 21km
Wilderness
Congress has designated more than 630,800 acres of Joshua Tree National Park as wilderness. Most of the park away from road corridors is wilderness. If you plan to venture into these areas, you must be familiar with special rules and regulations governing wilderness use.
North
0 5 Kilometers
0 5 Miles
Off road driving is prohibited
Unpaved road
4-wheel-drive road
Hiking trail
Ranger station
Picnic area
Medical facility
Interpretive trail
Campground
Group campground (reservations required)
Drinking water